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ABSTRACT

This paper describes the EQUALS teacher education program to assist educators in increasing participation of females in mathematics courses. The goal of the program was to increase educators' awareness of the issues surrounding the problem of mathematics avoidance among females, and particularly the future consequences for those students who avoided mathematics. Teaching strategies and materials were provided to actively engage students in doing mathematics and understanding the relevance of math to their future career options. The materials were presented in a workshop format to K-12 educators, as well as counselors, curriculum specialists, and principals. The impact of the workshop on participating educators was measured by surveying their satisfaction with program elements, their implementation of program activities, and their continued professional growth. (Author/DS)

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THE EQUALS TEACHER EDUCATION PROGRAM

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In 1977, the Lawrence Hall of Science (U.C. Berkeley) received a grant from the U.S. Department of Education for EQUALS, a program to assist educators to increase the participation of girls and young women in mathematics courses in their schools. Our goal was to increase educators' awareness of the issues surrounding the problem of math avoidance among females, and particularly the future consequences for those students who avoided mathematics. Then, we wanted to provide them with teaching strategies and materials to actively engage students in doing mathematics and understanding the relevance of math to their future career options.

In designing this teacher education program, we began with a number of beliefs. People cannot be made to change, but they can be encouraged to acquire and assimilate new information and use what they need, once they've decided there's a problem they want to tackle. People learn best when they're actively involved in the learning process and finally, people remember and act upon what has personal importance to them. From these beliefs, a program began to emerge that had three main threads:

Awareness activities to develop the background information concerning women and mathematics and to establish teacher ownership of the problem;

Competence activities to build confidence and skills in doing mathematics and in enhancing the mathematics curriculum; and

Encouragement activities to assist educators in using the materials in their schools and to stress the need for encouraging female expectations and aspirations.

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The Participants

Participants in the EQUALS staff development program have certain demographic characteristics that have remained consistent over the four years of our operation. Our population is about 70% female. Those who come to us have, on the average, ten years of teaching experience. They are usually evenly distributed between metropolitan and suburban school districts. Our minority population is about 35%, the majority of whom are black. We serve educators from the K-12 grades as well as counselors, curriculum specialists, and principals.

Educators learn about the EQUALS program from brochures mailed to their schools. Application is voluntary and successful applicants receive a $ 25/ day stipend for the five day program. EQUALS sessions are held on Fridays and Saturdays - 2 days in fall, 2 days in winter, and 1 day in spring. Since 1977, we have provided 30 hours of inservice to 400 educators at the Lawrence Hall and approximately ten hours of inservice to another 1,000 educators throughout California. In addition we have conducted EQUALS workshops for educators in Arizona, New Mexico, Kansas, Nebraska, and Nevada.

Format and Content of the Program

The EQUALS workshop model and support materials have been developed to accommodate a variety of mathematical backgrounds among the participants and varying amounts of time available for the workshop. The basic model has been used in inservice presentations with elementary, secondary, and college educators, as well as administrators, counselors, curriculum specialists, and parents. The materials presented during the workshop promote awareness of the problem of math avoidance, enhance problem solving skills in mathematics, and provide information about scientific and technical career opportunities.

To facilitate classroom use, the activities are conducted in the same way in which participants will use them with students. While the EQUALS training addresses the special question of math avoidance among women students, the information provided is essential for males as well. Thus, all materials, programs, and resources provided in the workshops are based in whole-class situations, and no students are excluded from the benefits of the program.

The three main components of EQUALS--increasing awareness; developing problem solving skills in mathematics; and encouraging career aspirations--are an integral part of every workshop, regardless of audience or duration.

Approximately one-third of our program is devoted to providing materials and instructional techniques in mathematics, although the career and awareness components include information relevant to mathematics teaching.

Within the mathematics component, we place our primary emphasis on problem solving for the following reasons: the apparent sex differences that have been reported in tests of problem solving abilities (California Assessment Program, 1979; 1980); the recommendation from NCTM that "problem solving should be the focus of mathematics in the 1980's" (National Council of Teachers of Mathematics, 1980); and the importance of using problem solving skills in preparing for and pursuing an occupation.

Educators come to EQUALS as students come to a classroom, with a wide range of confidence and competence in mathematics. By focusing on problem solving, we provide an introduction to the concept; show teachers how it can be a part of the curriculum, and introduce teachers to their own problem solving capabilities.

We use a variety of instructional formats and materials. We stress cooperation and most of our materials are best used by pairs of learners or small working groups. We examine the hated "word-problem" and present several approaches

to teaching students how to solve word problems: by organizing the information pictorially or in a tabular format; by recognizing and eliminating extraneous information; using guessing as a technique to approach problems that, at first, appear too complicated to attempt (each guess is seen as a hypothesis to be tested); and by simplifying the problem and looking for patterns. Further, we reinforce the problem solving skills that participants acquire by setting up "stations" - activities that provide experience in logical thinking, geometry, relations and functions, probability, measurement, operations, calculators and computers.

Stations are set up before the workshop so participants can work at them when they arrive and at lunch, in addition to the regular time provided for their use. Most activities presented in stations are sequenced from easy to hard to provide initial success for all participants and a challenge for the more experienced problem solvers.

IMPACT OF EQUALS

The evaluation of EQUALS proceeds on two levels: documenting the impact of the training on the participants, and the indirect effect on the students and in schools of participating teachers, counselors, and administrators.

The impact of EQUALS on participating educators is measured by surveying their satisfaction with program elements, their implementation of program activities, and their continued professional growth and development.

Satisfaction with program elements is ascertained in two ways, a daily rating scale and daily comment cards. The ratings of each program element by 1979 participants over the five-day series is summarized in Table I. The mean ratings range from 3.5 to 4.7 on a 5 point scale; the average rating overall is 4.2. Highly rated elements included role model panels (4.6, 4.4, 4.6, 4.3),

using microcomputers (4.6), and using hands-on materials (4.6), all of which are activities that the program endorses for classroom use. Less popular, though all well above "Average" in their ratings, included discussions of research (3.5), obstacles to implementation (3.9), planning of implementation (3.6), and math homework (3.6). The emphasis on having participants actively involved in the workshops seems to be having the desired effect in keeping the participants satisfied with the sessions.

Table I. Participants' Ratings of Program Elements (1979)

	Activity Name	Poor 1	2	Average 3	4	Excellent 5	Mean Rating
	Research Projects	1	2	21	45	28	4.0
	Research Summary	1	4	32	43	21	3.7
Day 1	Role Model Panel I	0	0	9	26	63	4.6
	Startling Statements	0	0	11	31	53	4.4
	Problem Solving:Cooperate	0	1	10	33	57	4.4
	Group Word Problems	0	1	10	35	54	4.4
	Geoblocks	0	1	12	34	49	4.4
	Greco-Latin Squares	0	2	12	33	49	4.3
Day 2	Venn Diagrams/Stations	1	1	10	39	35	4.2
	Effective Strategies	1	4	22	39	22	3.9
	Odds On You	0	0	9	34	51	4.4
	Multistep Word Problems	0	2	14	31	46	4.3
	Sharing Activities	0	4	9	21	49	4.4
Day 3	Role Model Panel II	2	1	9	19	53	4.4
	Math Stations	1	3	18	42	13	3.8
	Environmental Engineer'g	0	0	7	36	42	4.4
	Use of Stations	1	0	5	35	37	4.4
	Job Sort (elementary)	0	0	6	13	25	4.4
Day 4	Workforce (secondary)	0	0	7	13	23	4.4
	Why It Won't Work	1	4	17	37	22	3.9
	Brainstorm Solutions	1	3	17	38	22	4.0
	Role Model Panel III	1	1	7	18	51	4.6
	Planning Implementation	3	7	27	23	16	3.6
	Pets or Apples (computers)	1	1	3	13	53	4.6
Day 5	Role Model Panel IV	1	3	11	17	39	4.3

Table I. (continued).

	Activity Name	Poor 1	2	Average 3	4	Excellent 5	Mean Rating
	Math Homework Discussion	0	11	18	39	11	3.6
Day 5	Follow-up Research Disc.	1	5	34	21	10	3.5
	Journal Writing	3	3	24	21	18	3.6

At the end of the five days of training, participants are asked to rate the major components of the whole program. The question and responses from the 1979 participants are as follows:

"Thinking back over the five days of EQUALS workshops, please rate the following according to the degree to which you acquired information and skills in:"

Understanding the importance of encouraging girls in math	0	0	2	17	53	4.7
Using "hands-on" materials to teach mathematics	0	1	3	20	47	4.6
Incorporating problem solving activities into the classroom	0	3	7	20	41	4.4
Learning about fields of study and work that rely on math	0	2	6	31	33	4.3
Using EQUALS materials with students, colleagues, parents, and community people	0	1	14	25	31	4.2

Providing satisfactory training, however, is only a strategy for getting participants motivated to try the activities with their own students. The implementation of the activities between the first session in the Fall and the subsequent meetings in Winter and Spring is surveyed on a checklist of activities, summarized on Table II. Some EQUALS participants have little or no access to students with whom to try EQUALS activities, so that the somewhat low response

rate (79%) and the high implementation rate, averaging 72%, are spectacularly high. The most frequently implemented activities included some of the easiest to accomplish: sharing of information with various audiences (81%-94%); and some of the activities that demand the most planning to effect: role model visits to the classroom (84%) and use of concrete materials (75%). The least frequently implemented activity was the game, "Odds on You" (28%) which had received high ratings when evaluated on the day it was presented (averaging 4.4) but which requires several pages of duplicated materials per student. Given the constraints on most teachers to cover a standard curriculum that often omits the math activities advocated by EQUALS, the implementation rate of 58% to 77% is very impressive.

Table II. Participants' Implementation of EQUALS Activities (1979)

ACTIVITY	FREQUENCY OF USE (79 respondents) Not at all	1-2 times per class	More than 3 times per class	Percent using least
Results of your research project	13	55	11	84%
Startling Statements	15	47	15	78%
Role models in your classroom	13	48	18	84%
Odds on You	57	19	3	28%
Math activities:				
Cooperation	27	38	14	66%
Logical word problems	25	25	29	68%
Spatial activities (geoblocks, toothpicks, milk carton geometry)	18	30	31	77%
Attribute activities (graeco-latin squares, Venn diagrams, attribute blocks)	21	32	26	73%
Functions	33	30	16	58%
Multi-step word problems	24	28	27	70%
Use of concrete materials	20	23	36	75%
Sharing EQUALS information and/or materials with colleagues	5	24	50	94%
Sharing EQUALS information and/or materials with parents	15	30	34	81%

Average number of activities checked per respondent=9.4

Self-reported data, such as the checklists reported above, are given additional credibility by the entries that the participants make in their journals, which they keep to record their thoughts and feelings during the EQUALS inservice sessions and between times as they try various EQUALS activities.

For example, one junior high math teacher noted in her journal,

> "...games and puzzles in the classroom are tremendously effective in changing math attitudes. When students can associate a logic puzzle with math and succeed where they have not succeeded previously, they begin to make positive associations with math. Some students with excellent social skills who perceived themselves not mathematical discovered they could be successful in many of the activities."

A follow-up survey of all educators who had participated in EQUALS since 1977 was conducted this year. When asked, "What EQUALS materials have you used most fruitfully?" 92 (62%) listed various math materials and activities that had been presented.

Personal and Professional Development

In examining the program's impact on participants, we reviewed the journals for reports of their personal and professional growth. These tended to fall into several areas. One was the benefits gained from the exchange between participants.

Typical of many comments was this from a junior high teacher,

> "EQUALS has been a great source of professional growth for me. Seeing teachers doing things I would like to institute in my room, and sharing teaching ideas and techniques."

In some instances, this meant developing new organizational arrangements. One high school math teacher wrote,

> "My main reason for applying to the EQUALS program was to gain ideas for increasing our enrollments of girls in computer science...as students were being scheduled for second semester,

> It became apparent that we would not be able to get sufficient numbers together at any one time to form a class in the conventional sense. My colleague and I decided to put all the students in computer science into 'independent study,' providing the room and computers for them for five time slots per day. Inasmuch as our high school only has six periods in the day, this means we provide before and after school supervision. Our idea succeeded beyond our most optimistic expectations; we wanted 25-30 students, we got 58, and we quadrupled the number of girls (from 4 to 16)."

In others, it meant a personal development, in this case a growth in self-confidence,

> "I have learned quite a bit about myself. I have discovered that I am not unable to do math, which proves the point it is never too late."

And in this one, a new approach to teaching,

> "I have found that I do not have to be in total control of the class at all times. I was always afraid to move off the straight line of my objective. I have learned that my teaching objective can be reached by other means. You have changed my opinion about workshops and what can be done in the classroom. You have helped me to learn new things about students and to gain a better understanding of myself. You have given one the opportunity to try things I never would have done on my own."

In sum, EQUALS' impact on participants included high satisfaction, relatively impressive implementation of activities, and evidence of professional growth and development.

Impact of EQUALS on Students

Because the effectiveness of any teacher-training program can ultimately only be measured by the impact on the students of those who are trained, the project seeks to determine the effectiveness of the training on students of EQUALS participants in two important areas: their interest in math-based careers and their attitudes toward mathematics.

Interest in math-based careers has been found in many studies to increase students' likelihood of enrolling in elective mathematics courses. In the previous EQUALS evaluation, the Career Awareness Survey (CAS) was used to

ascertain the interest of students in a variety of careers and no significant increases were found as a result of the EQUALS activities. Since that time, the career awareness strand of the program has been strengthened and the results are moderabely favorable. The results of the CAS are shown in Table III. There is widespread sex-role stereotyping of careers by the approximately 1350 students who responded to this survey both before and after the students engage in EQUALS activities. Significant increases in interest are found for males and females in four careers, however: engineer, architect, computer programmer, and dental technician. In addition, males increase their expression of interest in four of the occupations which were more frequently chosen by females: teacher, secretary, sales clerk, and doctor. While these gains must be considered modest, they are certainly in the desired direction of increasing students' openness to consideration of a variety of career options.

For younger students, from kindergarten through grade three, an instrument such as the CAS is inappropriate since it uses occupational names with which young children are not familiar. Pictures are more suitable but photographs or drawings of people whose gender is identifiable are likely to be selected by young children on the basis of gender alone. In an effort to conteract this tendency, The Bears were devised. As the accompanying figure shows, drawings of bears are presented for six common occupations and students are asked to select which ones they would like to try for a day. The students' responses before and after their experiences with EQUALS activities are summarized on Table IV. As with the older students, the primary students made their selections consistent with sex role stereotyping of the occupations. In fact, their answers were consistent in forming two scales: a masculine occupation scale containing carpenter, scientist, and engineer; and a feminine occupation scale containing

Table III. Students' Interest in Careers from the Career Awareness Survey (in which they indicate which careers they would like to try for a day).

Occupation Selected	Male Students		Female Students	
	Preceeding EQUALS Activities n=710	Following EQUALS Activities n=655	Preceeding EQUALS Activities n=705	Following EQUALS Activities n=640
Carpenter	43%	48%	12%	15%
Nurse	2%	4%	46%	48%
Engineer	41%	50% *	15%	19% *
Bartender	33%	39%	29%	28%
Architect	37%	44% *	25%	31% *
Computer Programmer	39%	47% *	32%	40% *
Teacher	15%	22% *	50%	50%
Athlete	59%	54%	38%	39%
Secretary	2%	6% *	51%	46%
Trucker	50%	45%	31%	34%
Ranger	44%	47%	34%	33%
Scientist	39%	41%	27%	27%
Police	34%	37%	29%	31%
Mechanic	42%	42%	13%	13%
Sales Clerk	10%	17% *	41%	42%
Artist	30%	30%	46%	43%
Veterinarian	23%	23%	50%	47%
Dental Technician	10%	14% *	21%	27% *
Doctor	31%	39% *	38%	42%
Military	30%	32%	11%	13%
Telephone Operator	8%	10%	33%	32%
Plumber	12%	11%	2%	4%
Lawyer	44%	47%	51%	52%

*Indicates that the difference in the two percentages is statistically significant at the .05 level, i.e. that the likelihood that the observed difference would occur by chance is less than 5%.

AGE _____ TODAY'S DATE _____ TEACHER _____

SEX: MALE ____ FEMALE ____ GRADE ____ SCHOOL _____

Which jobs would you like to try for a day?

NURSE 1

SCIENTIST 2

TEACHER 3

ENGINEER 4

SECRETARY 5

CARPENTER 6

Figure 1.

EQUALS

Table IV. Students' Interests in Careers from The Bears (a career interest measure for students in grades K-3 in which they indicate which jobs they would like to try for a day).

Occupation Selected	Male Students Preceeding EQUALS Activities n=300	Male Students Following EQUALS Activities n=300	Female Students Preceeding EQUALS Activities n=300	Female Students Following EQUALS Activities n=300
Nurse	12%	12%	62%	69%
Scientist	67%	83% *	29%	48% *
Teacher	30%	30%	87%	80%
Engineer	65%	79% *	19%	28% *
Secretary	23%	23%	74%	71%
Carpenter	69%	75%	24%	28%

*Indicates that the difference in the two percentages is statistically significant at the .05 level, i.e. that the likelihood that the observed difference would occur by chance is less than 5%.

teacher, secretary, and nurse. When the individual choices are examined, it is found that boys and girls significantly increase their expressed interest in being scientists and engineers, with no significant changes in any of the other careers. These gains are more substantial than those observed for the older students, particularly the increase in girls' interest in trying the occupation "scientist," which doubled from 29% to 48%.

The second student characteristic surveyed prior to and following the EQUALS teachers' use of activities was attitude toward mathematics, measured on the Mathematics Attitude Scale (MAS). The scale, presented in Figure 2, includes items on enjoyment of math, perceived usefulness of math, and feeling of confidence in math -- all found to be important in achievement in math and election of math courses. An analysis of variance on the MAS found that there was a significant improvement in positive attitude towards math among the high school students. There was not a significant change at the junior high level. The lack of improvement at the junior high level may reflect the difficulty of influencing a group for whom peer attitudes are valued over adults'; some investigators have actually observed a decrease in positive attitudes advocated by a sex stereotyping intervention with this age group.

Summary

Several sources document the effects of the EQUALS training on participating educators. Their satisfaction with program activities is high in general, and they report that they gained information in skills in particular. Their reports of implementation of EQUALS activities with students, indicating that the majority of the teachers employ a majority of the activities, are substantiated by journal entries that show how educators have internalized and incorporated EQUALS strategies into their classrooms. The journals also

Figure 2

MAS

Grade _____ Today's Date _____

Age _____ Teacher _____

Sex: male ____ female ____ School _____

DIRECTIONS: A number of statements which people have used to describe how they feel about math are given below. Read each statement and circle "Y" for YES if the statement describes how you feel about math and circle "N" for NO if the statement does not describe how you feel about math.

YES	NO		
Y	N	1.	I think math is fun.
Y	N	2.	I'm sure I can do advanced work in math.
Y	N	3.	I like to do math puzzles.
Y	N	4.	I put off my math homework until last.
Y	N	5.	No matter how hard I study, I will get low grades in math.
Y	N	6.	I think math games are boring.
Y	N	7.	I do as little work in math as possible.
Y	N	8.	Math is not useful to me.
Y	N	9.	I will need math for my future work.
Y	N	10.	I think everyone can learn math.
Y	N	11.	I like to think about math problems after class.
Y	N	12.	I wish I were smarter in math.
Y	N	13.	I get nervous studying for a math test.
Y	N	14.	Math is hard for me.
Y	N	15.	I feel anxious in math class.
Y	N	16.	I guess a lot on math tests.
Y	N	17.	Math is easy for me.
Y	N	18.	I will use math in many ways when I get out of school.
Y	N	19.	I think math is awful.
Y	N	20.	Most jobs require some math.
Y	N	21.	I don't expect to use math when I get out of school.

provide evidence of personal and professional growth beyond the classroom as teachers become leaders in equity efforts in their districts.

Effects on students of participating educators are also documented. Increased interest in a wider spectrum of careers is shown on the Bears for primary students and the Career Awareness Survey for older students. Improved attitudes towards mathematics are also observed in some, though not all, age groups. These attitudes towards careers and mathematics are precursors to continued study of and success in mathematics courses.

In sum, the EQUALS training seems to be effective in making changes in a number of factors that contribute to equity in math-related fields.

Impact on Institutions

The impact of EQUALS in the schools can be measured by the request for additional workshops and assistance. In 1980, 65 districts in Northern California requested that we provide their staff with training. A number of principals and curriculum coordinators have begun to set up workshops for their staff in addition to the regular program we offer. The increased interest of principals and inservice educators, as evidenced by their high application rate, indicated that educators at all levels and responsibilities are viewing the program as a positive inservice experience. The reason for this is that it offers a participatory model of staff development.

Another indication that the EQUALS program is being institutionalized within school districts is demonstrated by the existence of four district-wide spinoffs:

San Francisco Unified School District received a grant for 1980-81 from the California State Department of Education (ESEA, IV, Part C) to conduct workshops for 530 students and 50 educators to increase young women's participation in mathematics. Evaluation will focus on assessing the affective and

behavioral changes in students and educators participating in the program compared to a matching sample of nonparticipants.

Novato Unified School District received a third year of funding from the U.S. Department of Education to conduct the Novato Math/Science Sex Desegregation Project for district educators. Activities focus on resources and materials for nonsexist math, science, and career education topics. The staff members are former EQUALS participants.

Emeryville Unified School District also received a third year of funding from the Department of Education to promote sex-fair mathematics instruction and counseling for forty of the district's educators. Eight inservice days during the academic year and a five-day summer workshop provide participants with extensive training in the EQUALS materials and methods by a former EQUALS participant.

Napa Valley Unified School District received Title IV funding to conduct a 1980-81 program for educators throughout their district. The project director was a 1979 EQUALS participant.

Dissemination of the Program

The EQUALS project had not plans to disseminate the materials produced during the training. However, due to the uniqueness of the approach to sex equity through mathematics, the project has established both a local and national reputation as a resource for educators who wish to reverse the pattern of math avoidance among female students.

A handbook detailing the teacher education program developed is now available. Entitled, Use EQUALS to Promote the Participation of Women in Mathematics, the handbook sets forth the rationale for the program, describes

typical workshop models, details the three major components of the training (increasing awareness, developing problem-solving skills, and encouraging career aspirations), provides numerous classroom activities and suggestions for how to integrate them into the curriculum, suggests evaluation measures, and lists a number of resources for additional assistance. Since October 1980 when it became available, 1,000 copies have been requested by educators.

EQUALS has been effective in establishing a model program to assist educators in obtaining methods and materials to increase awareness of the need for math participation of female students. The numerous requests for materials and consultants to conduct additional workshops indicate that the school community is now ready for a major effort to effect change in the course enrollment patterns of women students.

EFFECTIVE STRATEGIES

Those program characteristics that appear to be the most effective year after year are the following:

1. Establishing ownership of the problem. We involve participants in a research project before they attend their first EQUALS meeting. By collecting data on a substantive issue in women and mathematics, the participants become the "experts" on the situation in their schools. They begin to define the problem and are ready to share ideas to arrive at solutions with other participants.

2. Providing materials that are immediately usable in the classroom. Whether they're mathematics or career materials, if they need revisions or adaptation, the likelihood they will be used is low. Additionally, providing time during the inservice for participants to become comfortable with the materials is essential.

3. Providing role models and being a role model. Role models of women who work in math-based field and of teachers who have successfully used EQUALS materials will inspire and motivate participants. Providing an inservice experience in which the staff works cooperatively, is responsive to participants' concerns, and have had the experience of being classroom teachers themselves is critical to conveying a non-threatening, well-planned, and enriching inservice.

4. Encouraging professional development. Viewing the participants as leadership personnel, providing suggestions and resources to enable them to take the first step toward leadership, and being an on-going support group to them will yield the most profound results. This "trainer of trainers" model can succeed beyond all expectations if there is a built-in assumption that participants will begin to see themselves as advocates and leaders in achieving the goals of the program.

HOW TO ADAPT THE MODEL

A number of resouces exist for local adaption of the EQUALS program. The most obvious is the EQUALS handbook, which can be used in a number of ways to design your own program.

We have also begun a program to train out-of-state educators in EQUALS methods and materials. This year, fifteen educators came to Berkeley from Arizona, Pennsylvania, New York, North Dakota, South Dakota, Maine and Montana to take this training and they are now actively developing programs in their own area. This program will be continued in 1981-82 if funding is provided by the Department of Education.

Federal and State monies have been used by local adapters to set up programs like EQUALS in their areas. In particular, Title IV funds from the

Department of Education and Title IVC funds from the State Departments of Education have been identified as appropriate resources.

Finally, your most important resource is the people you know who are concerned about the issues of women and mathematics and are committed to developing an action plan. A core of advocates - a network - can accomplish far more than one or two individuals. Begin to plan cooperatively, develop a collective vision and work toward it together.

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